



GROWING SOUTH DAKOTA

A MAGAZINE BY SOUTH DAKOTA STATE UNIVERSITY
COLLEGE OF AGRICULTURE & BIOLOGICAL SCIENCES / WINTER 2016



Beef Reproduction & Efficiency

Addressing Saline & Sodic Soils

Opportunities For
Carinata Explored

South Dakota
Agricultural
Experiment Station



Research
at SDSU

2015 Annual Report



FROM THE DEAN:

Shaping the Future

"It suddenly breaks on all human vision that man, cleaving the air like a bird, can rise to immense heights and reach immeasurable distances."

– Bishop Milton Wright, Father of Wilber and Orville Wright, on his son's achievement of flight in 1903

I AM CAPTIVATED BY THE CREATIVE GENIUS of the individuals who have shaped our modern world. While their ingenuity is breathtaking, their sheer tenacity is almost mind boggling. The advancements made in the late 19th and early 20th century by Nikola Tesla, Thomas Edison, Alexander Graham Bell, Louis Pasteur, Marie Curie and the Wright Brothers set the stage for the energy, communication, medical and transportation systems that we all enjoy today.

But when it comes to agriculture and food, the advancements we enjoy and benefit from today in terms of production efficiency, availability, accessibility, nutrition, safety and ultimately cost have their roots firmly in the research productivity of the Agricultural Experiment Stations of the land-grant universities like South Dakota State.

Sadly, the heroes of the agriculture and food revolution aren't as well-known as their contemporaries from other fields. In part, it's due to the collaborative nature of the land-grant system in which they worked.

But I also believe there was a fundamental difference in the entrepreneurial spirit of the Edisons and Bells, versus the servant hearts of scientists like South Dakota State's own Edgar McFadden, whose stem rust resistant variety of wheat, named "Hope," has been long credited with helping to win the second World War. McFadden both literally and figuratively gave "Hope" to the world to the benefit of billions of people.

There are two widely discussed aspects of the wonders of modern agriculture that I believe are not fully appreciated or understood. The first has to do the number of people fed by a single American farmer. According to the USDA, when I was growing up in the 1950s, an American farmer fed approximately 25 people. As the post war technology revolution kicked in, that number increased exponentially.

Today, a single farmer feeds an estimated 155 people. While numerically impressive, its true impact is simply amazing. The difference in those two figures represents the release of the human creativity and productivity of 130 people whose energies have been turned from producing food to curing cancer and improving our health care. Their time has been released to revolutionize our communication, transportation, and energy systems. Their interests and passions have been freed to enhance the quality of our lives with art, music, and literature. And at the same time, we have been provided with the most nutritious, least expensive food in the history of man.

The second is the widely quoted figure that in 2015, an American household spends approximately 10% of its disposable income on food. Again, as a child in the 1950s, my parents spent approximately 25% of their disposable income to feed our family.

That difference of 15 cents out of every dollar that can now be spent by families on things other than food, has been the fuel for the immense improvement in standard of living for Americans.

While I am not insensitive to the continuing challenges of poverty in our communities, state, and nation, I am amazed at the access for most of us to everything from cellphones to air travel. And it manifests itself in many fundamental ways. My father was born in 1921 and lived until he was 72. My life-expectancy is 16 years longer than my father's. My sons' are nearly a decade longer than mine. Things like taking early retirement, buying a personal water craft, going on family trips to theme parks, and having destination weddings are now choices made possible by the availability of income for things other than food. And at the same time, we benefit from the safest, most diverse food system in history.

Feeding over 9 billion people in 2050, known as the "Grand Challenge of the 21st Century," brings with it a need for a renewed commitment to invest in agricultural research. I am heartened that in South Dakota, here at SDSU, we are doing just that.

Over the last several years we have opened new research facilities for plant genetics and dairy manufacturing and remodeled research labs for multiple departments. We currently have major building projects underway for swine and cow-calf research which will open in 2016. And construction for new greenhouses and a plant science support facility will also begin in 2016. Plans are also being developed for other new facilities. These facilities, and the brilliant faculty scientists working in them, will enable us to not only meet the challenges of the future, but to shape it.

Kevin Kephart, SDSU's Vice President for Research and Economic Development, likes to share this comment as a reminder of the challenge before us all: *"At a young age, Edgar McFadden dedicated his life to conquering a disease in wheat that threatened the food security of our nation and the world. He serves as an inspirational role model for us all as we work to conquer new challenges in a modern world."*

The College of Agriculture and Biological Sciences is conquering new challenges and finding better ways to overcome those that are recurring. This is made possible through investments in infrastructure and talented people.


BARRY H. DUNN, PH.D

GROWING SOUTH DAKOTA

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On the Cover: Improving reproductive
efficiency in beef cattle is the focus of
research conducted by animal scientist
George Perry. Read more about his work
beginning on page 3.

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FROM THE DIRECTOR:

Optimizing Resources For Food – And Future Generations

YOU HAVE HEARD THE NUMBERS, probably many times: the global population is growing and is expected to grow to over 9 billion people in 2050. Affluence is increasing in some population sectors as well, and hopefully

will continue to increase. Not only will these two or so billion additional people need food, but they will also expect their growing affluence to provide access to interesting food choices. These are choices that most of us are accustomed to having for ourselves, and we expect that we'll always have those choices, in abundance. None of us are disinterested parties observing from the sidelines. Most of us have a direct or at least an indirect involvement in growing, processing and distributing food, and all of us are avid consumers of food.

The discussion is not just about food. The discussion is also about land, water and energy, natural resources and ecosystem health, and human health and wellbeing. The considerations are not just important for us today, but also for those who will come after us, the next generation and the generations that follow.

South Dakota agriculture has done a remarkable job over the last century and longer to take care of more than its fair share of global food, fiber and energy needs. But the needs will continue to grow over the coming decades and South Dakota needs the best information and technologies possible to optimally balance its use of resources in order to meet needs for food, energy and water, both today and on into the future.

We have much of the necessary knowledge already, but some of the knowledge we need is yet to be discovered through research. Some knowledge could be better utilized if laws and markets were better optimized for near-term, as well as long-term, benefit.

South Dakota occupies a unique position in North America. That is why the Hatch Act of 1887 was so significant; it provides for research specifically oriented toward the needs of South Dakota in the areas of agriculture, natural resources and rural health to invent, develop and apply technologies and to inform policy development with pertinent scientific knowledge. The South Dakota Agricultural Experiment Station at South Dakota State University (SDAES) exists by virtue of and for fulfillment of the Hatch Act of 1887.

This issue of *Growing South Dakota* is the 2015 Annual Report of SDAES. We report on a wide variety of ongoing research to provide some insight into the breadth of our responsibility toward South Dakotans.

I hope that you get as excited as I do about the research results flowing out of our laboratories. You will read that our excellent research faculty are finding better ways to be more efficient in the primary production of our chief agriculture products and to be more effective at optimizing our natural resources. This is good for profitability, good for consumers around the globe and good for future generations. They are also finding new uses for value-added products and even making discoveries about potential new crops that could fit into South Dakota systems.

I recently came into possession of *The Sun Shines on South Dakota*, a collection of short essays written by Louis N. Crill, who passed away in 1929 while serving as Secretary of Agriculture of the State of South Dakota. Mr. Crill had an enthusiastic vision of diverse opportunities for South Dakota agriculture. Some of his visions came to pass, others did not. That was nearly 100 years ago, and opportunity still knocks for South Dakota to do well during the next 100 years.

Enjoy this research issue of *Growing South Dakota*. As always, your comments are welcome. We are always happy to receive your e-mails at sdsu.agexperimentstation@sdstate.edu.

DANIEL SCHOLL

Director, South Dakota Agricultural Experiment Station at SDSU
Associate Dean for Research, College of Agriculture and
Biological Sciences

TABLE 1

Distribution Of Total SDAES Expenditures Among
Areas Of Research – Fiscal Year 2015

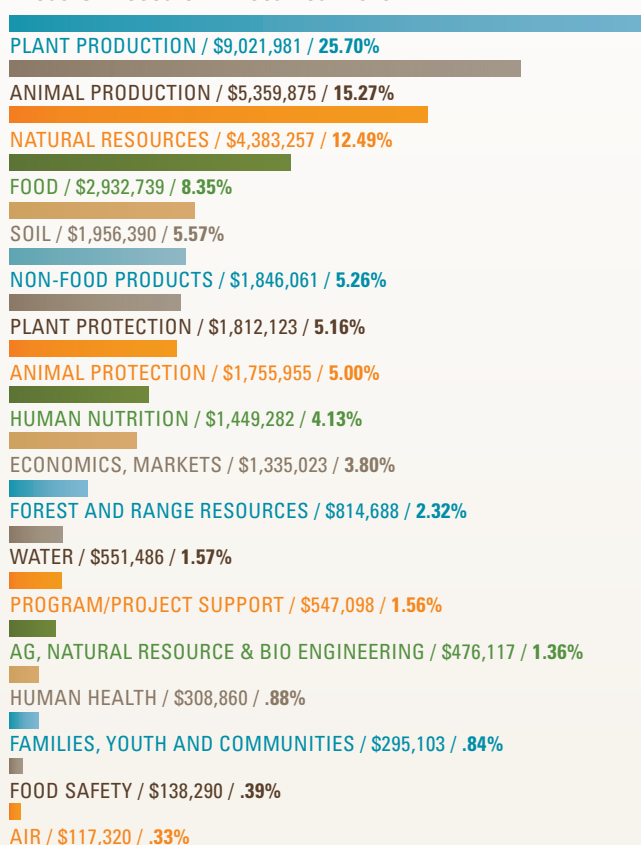
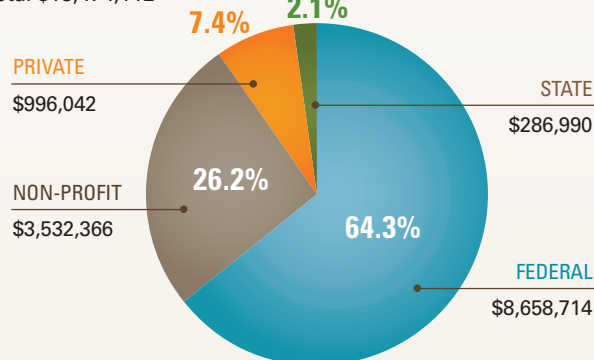


FIGURE 1

SDAES External Research Funds – Fiscal Year 2015

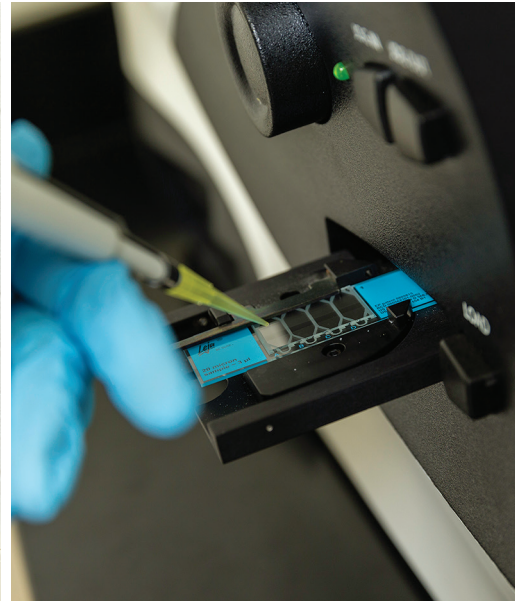
Actual Expenditures

Total \$13,474,112



Concentrating On Cattle

Researcher Studying Mechanics To Improve Reproduction Efficiency In Beef Cattle



Pictured: Professor George Perry and student Jerica Rich review data being collected to better understand reproductive efficiency in beef cattle.

CATTLEMEN UNDERSTAND that getting more cows bred means the opportunity to produce more calves – which in turn equates to more beef to sell. Not only does that increase the economic return to the rancher, it also has an important role in increasing domestic and global beef supplies.

For the future, producing more beef is an especially important aspect with the projection for the global population to add 2 billion more people to the planet over the next 35 years. As a result, the world is racing to address the “Grand Challenge of the 21st century” of ‘How do we feed more people?’

SDSU animal science professor and beef reproduction extension specialist George Perry is conducting research that may contribute to the solution. Perry’s research over the past decade has focused on reproduction efficiency in beef cattle. It goes back to that basic premise of more cows bred means the opportunity for more calves and more beef produced.

Perry says, “All ag sectors are looking at production efficiency as we address the Grand Challenge of the future. Dairy is looking at producing more milk, poultry is looking at more eggs, swine is aiming to add more piglets in a litter. We in the beef industry are taking the approach that asks ‘How can we get more cows bred early?’”

Perry reports that research data has shown that beef cows that are bred earliest in a breeding season are more productive (i.e. have more calves) during their entire life cycle. To that he says, “If we can get more cows bred early, we can produce more beef.”

Presently, Perry notes that beef producers do face challenges with conception rates. He reports that when a cow shows estrus and ovulates and semen is present from artificial insemination or natural service, fertilization occurs 90% of the time. But conception rates usually only average 50 to 60%. “This equates to a 30-40% embryonic loss. If we can get more of these embryos to survive – even

if conception rates were 75% – that many more cows bred and producing that much more beef over their lifetime would benefit the world’s food supply,” says Perry.

FOCUS ON ESTRADIOL

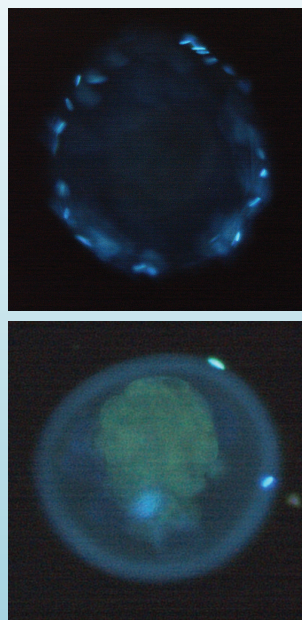
Perry’s reproductive work with heifers and cows is focusing on the hormone estradiol. “Estradiol is the signal to the brain for onset of estrus,” Perry explains. Different levels of estradiol appear to result in differences in estrus expression.

From data collected on 10,000 cows synchronized with recommended fixed time artificial insemination (AI) protocols, Perry and his team of researchers identified a 27% improvement in animal conception rates among those cows and heifers with high levels of estradiol. Those results mean estradiol prompted the opportunity for an extra 27 calves out of 100 cows.

Presently, estradiol cannot legally be administered to cattle. Thus, Perry says, “We need to figure out how to get the body to produce estradiol.”

EGGS & ESTRADIOL

Pictured below: Students Emmalee Northrop (left) and Jerica Rich conduct lab analysis on the hormone estradiol for this research.



Cows that have elevated concentrations of estradiol prior to fixed-time AI have over twice as many sperm reach the site of fertilization as cows that have low concentrations of estradiol prior to fixed-time AI.

Top – an oocyte (egg) from a cow with elevated concentrations of estradiol prior to fixed-time AI that has numerous accessory sperm attached to it. **Bottom** – an oocyte (egg) from a cow with low concentrations of estradiol prior to fixed-time AI that has only 3 accessory sperm attached to it.

This research was recently recognized by the SDSU graduate school when Erin Larimore won the 2015-16 SDSU Distinguished Master's Thesis Award from the SDSU Graduate School. Her thesis was selected as the top thesis in Biological/Life Sciences among students who graduated between July 1, 2013 and June 30, 2015. To be selected for this award, a thesis must contain original work that made an unusually significant contribution to the discipline. Having won the SDSU award, the Graduate School nominated her thesis for the 2016 Midwestern Association of Graduate Schools Distinguished Master's Thesis Award. Erin graduated from the SDSU Animal Science Department in August 2014 with George Perry as her advisor. Her thesis title was, "Changes in ovarian function associated with circulating concentrations of estradiol during the pre-ovulatory period and its influence on sperm transport and embryonic development."

His current research is focused on studying what regulates production of estradiol by the follicle and evaluating what might prompt increased production of the hormone in some animals and not others.

An additional study is evaluating what estradiol does in the uterus to aid beef cow conception rates and embryo survival. "At Day 6 (after fertilization) we are seeing improved embryo quality when there are high concentrations of estradiol, and by Day 16 estradiol also appears to prompt beneficial changes in the uterine environment," Perry reports.

STUDYING BULLS, TOO

From this research, a third area to evaluate was identified – sperm transport. "We are looking at what factors may influence better sperm survival and fertilization," Perry explains. He points out that sperm in the epididymis can live for a few weeks, but in lab cultures only for a few days and in the reproductive tract for a few hours. As well, the cryo-packaging process for

semen to be used for AI can negatively impact sperm survivability.

"We need to learn more about the proteins that surround sperm and the environments we ask sperm to live in," says Perry. For instance, he points to the fact that among poultry, hens can store sperm and fertilize an egg each day for a week. He believes it may be related to the protein that surrounds the sperm.

Perry believes with more information, the beef industry can eventually better identify which sperm will do better [at fertilization]. He notes that currently a Breeding Soundness Exam looks at motility and morphology of a bull's sperm. But that bull may still have poor conception rates. The research he's conducting aims to learn more about the fluid that the semen is in. "Some sperm may have higher survivability based on the protein that surrounds it," says Perry.

As new information is gleaned from this research, Perry says better technologies to store semen and increase conception rates through AI may be developed.

For beef producers, especially those in developing countries, this could be a game changer. Perry explains, "One bull requires a lot of resources. If producers can replace that bull with a female and use AI instead to improve conception rates, we can increase beef production – the world would have more beef."

By Kindra Gordon

Editor's Note: Over the past decade, George Perry has worked on this research with 11 graduate students, 7 undergraduate students and several technicians. Funding support has been provided from the National Science Foundation, USDA National Institute of Food and Agriculture Hatch funds through the South Dakota Agricultural Experiment Station, SARE, and industry organizations including AI and animal health companies. Perry also acknowledges that many producers have provided access to their cows, and he says, "The fun part of this has been having producers involved."

At The Forefront

SDSU Diagnostic Lab and Veterinary and Biomedical Sciences
Scientists Sequence Avian Influenza Genome

THE ANIMAL DISEASE RESEARCH AND DIAGNOSTIC LABORATORY and Veterinary and Biomedical Sciences Department at South Dakota State University has a reputation for quick response to emerging infectious diseases, but those capabilities have now been expanded to genetic sequencing.

In only one week, ADRDL scientists sequenced the genome of the highly pathogenic avian influenza (HPAI) virus that affected poultry operations along the Mississippi flyway last spring.

ADRDL scientists received samples from an Iowa poultry operation on April 19, 2015, according to Diego Diel, an assistant professor in the SDSU Department of Veterinary and Biomedical Sciences. The researchers used the lab's new next-generation sequencing capabilities to accomplish the task so quickly.

They were among the first researchers in the nation to sequence strains associated with the 2015 outbreak, Diel says. Simultaneously with the SDSU team, researchers in the state of Washington and at the National Veterinary Services Laboratories in Iowa sequenced the viruses that affected poultry along the Pacific and Mississippi flyways.

The results of Diel's work were published in the May/June 2015 issue of the American Society for Microbiology Genome Announcements. Other SDSU authors are research associate Travis Clement, assistant professor Joy Scaria and professors Eric Nelson and Jane Christopher-Hennings, who is head of the Department of Veterinary and Biomedical Sciences and ADRDL director.

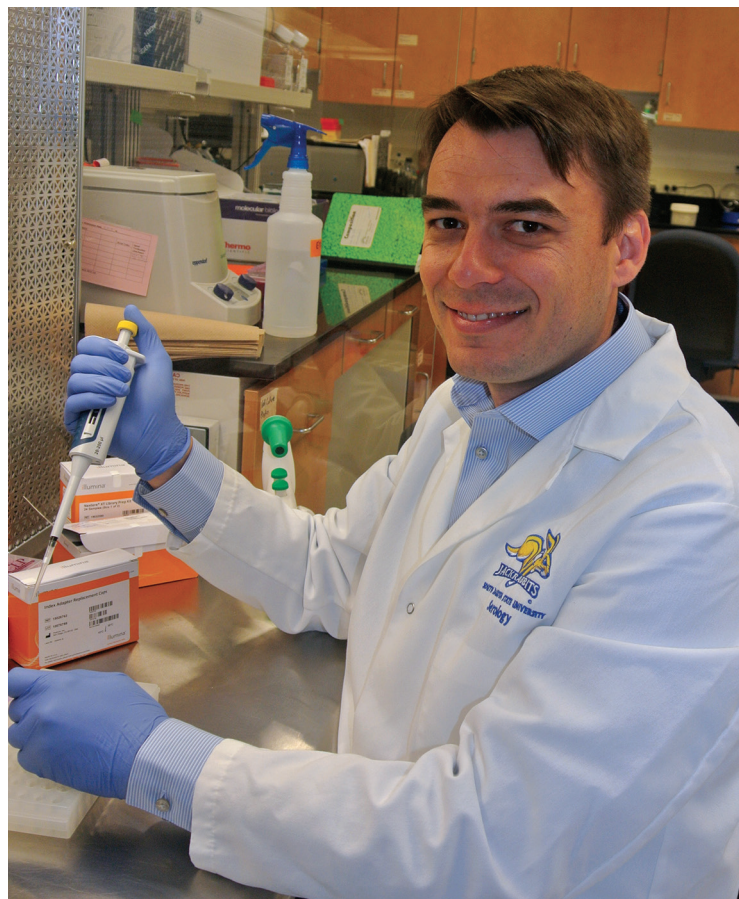
"No sequences were available when we received the first samples for testing," says Diel. Sequencing the genome is the first step in understanding the virus epidemiology and provides critical information for developing diagnostic tools and vaccines.

Two features of the avian influenza virus make developing a vaccine difficult, according to Diel. Avian influenza is an RNA virus, which can quickly mutate to avoid detection by the immune system. Also, the influenza genome is composed of eight RNA segments that can reassort or shuffle between two influenza viruses, thus originating different virus strains.

"Two different virus strains can infect the same host cell and, from that co-infection, a third strain can be generated," explains Diel. "It is really challenging."

Though evidence suggests that the virus originated from wild birds, how it spread in poultry is still unclear, Diel points out. Considering the number of farms affected and, in most cases, the random distribution of those, it is likely that multiple pathways account for its spread.

Furthermore, Diel explains, due to the involvement of wild birds in the epidemiology of the virus, predicting when and where the virus might emerge again is a very difficult task. Strict



Pictured: Virologist Diego Diel, an assistant professor in the SDSU Department of Veterinary and Biomedical Sciences, prepares DNA libraries for sequencing.

biosecurity measures will help protect poultry operations, while surveillance of wild birds may allow early detection of HPAI viruses.

The swiftness with which ADRDL is able to sequence emerging infectious agents will allow scientists to identify whether any subsequent outbreaks involve similar strains of the virus, according to Diel. These next-generation sequencing capabilities keep ADRDL at the forefront in developing new diagnostic and intervention strategies to combat emerging infectious diseases of livestock species.

By Christie Delfanian

Funding for this research is supported from the ADRDL and USDA National Institute of Food and Agriculture Hatch funds through the South Dakota Agricultural Experiment Station.

Seeking Superior Wheat

Breeder Using Extensive Genome Testing To Improve Winter Wheat Cultivars

WINTER HARDINESS, HIGH YIELDS, disease and drought resistance and good end-use quality – those are the traits that wheat breeder Sunish Sehgal is striving to cultivate through his winter wheat breeding program.

“We must increase the productivity of the wheat plant itself, but do so in a sustainable way, without damaging the environment, while also reducing costs

of production,” says the South Dakota Agricultural Experiment Station researcher. Funding for SDSU’s winter wheat research comes from the USDA National Institute of Food and Agriculture through the South Dakota Agricultural Experiment Station and the South Dakota Wheat Commission.

Sehgal came to SDSU in 2014 after more than seven years at Kansas State

University, where he worked on wheat genome mapping and sequencing and assessing genetic diversity. He was scientific manager and one of the lead investigators of the nation’s first National Science Foundation Industry/University Cooperative Research Center in crop genetics.

To feed the increasing global population, projections suggest world





“I grew up with wheat and I absolutely love wheat,”

says SDSU’s winter wheat breeder Sunish Sehgal of his commitment to the profession.

The India native was born in the northern India region near Delhi, which is called the nation’s breadbasket. India ranks No. 3 in world wheat production, behind only the European Union and China and ahead of both Russia and the United States, according to FAOSTAT 2015.

Sehgal earned his doctorate in plant breeding from Punjab Agricultural University. He recalls sleeping in his lab for four years as a doctoral student to protect his seedlings, after losing his work twice in 15 days when a freezer malfunctioned. Because India doesn’t have long days like South Dakota, Sehgal says, “My field had huge lights to make plants flower.”

In 2005, he showed his work to world-renowned wheat scientist Norman Borlaug (*inset photo*). Sehgal points to Borlaug and Edgar McFadden, who developed a spring wheat variety “Hope” that was immune to stem rust, as people who helped shape his thinking when it comes to wheat breeding.

NEAT TO KNOW ABOUT WHEAT

- Each wheat plant harvested averages 85 seeds.
- It takes 10 wheat plants to make one slice of white bread.
- On average, each person eats the equivalent of 50 wheat plants a day (counting any food item made with wheat).
- It takes a tennis-court-sized field of wheat to feed a family of four for a year.

wheat production must increase by 2% each year, Sehgal explains, but the average increase in production is now only 1%.

He points to climate change as a major challenge facing breeders and producers. “We’re experiencing more abrupt fluctuations in weather that can adversely affect production,” he says. A 1-degree temperature increase can cause as much as a 20 to 30% reduction in yield.

EXPLORING DIVERSITY AND GERMLASM

To increase favorable genetic variation, Sehgal must first identify parent plants with the traits he seeks. He evaluates germplasm and cultivars from regional nurseries such as those in Kansas, Nebraska, North Dakota and Montana, for yield and resistance to pest and diseases in several South Dakota environments. Sehgal utilizes them to develop more than 500 new genetic combinations each year.

In addition, he and his graduate students are also recreating the cross that produced bread wheat in nature about 10,000 years ago. He is crossing wild

wheat and pasta wheat, which exist in both wild and cultivated varieties. “This happened only twice in nature,” he says, noting that only certain traits went into the bread wheat.

His research team screened parent plants with the molecular markers to identify a core set of 60 pasta wheat varieties that they are mating with similarly screened wild wheat to make 100 new wheat lines.

“Some of these lines have 20 to 22 percent protein,” Sehgal says, in comparison to the typical 14 to 15% protein content in bread wheat. “We want to mobilize this variability into bread wheat.”

RESPONDING TO PRODUCER NEEDS

Sehgal points to cold tolerance as his No. 1 breeding priority. South Dakota farmers plant 1.5 million acres of winter wheat, but anywhere from 250,000 to 500,000 acres can be lost due to winterkill and drought.

“That’s why some producers shy away from winter wheat,” he says. This year lack of moisture was a concern in March, but May rains helped the crop recover enough to produce up to 75

bushels per acre in some areas, Sehgal explains. Expansion of the federal crop insurance program to allow farmers in 16 northeastern South Dakota counties to insure their winter wheat crop may also help increase production area.

In addition, Sehgal cites identifying resistance to diseases, including leaf rust and wheat streak mosaic virus, and insect pests as major challenges. However, he notes that recently bacterial leaf streak and stripe rust have also caused significant damage in some regions.

Furthermore, producers want shorter varieties that have less straw and ones that mature earlier without sacrificing yield, according to Sehgal. This may also give farmers the option of growing a second crop, may reduce terminal stress or better fit their schedule.

Exploiting genetic diversity while using new scientific and breeding techniques like doubled haploids and genome-wide selection will help increase the pace of wheat improvement, Sehgal explains.

“Breeding is a numbers game – the more combinations we test the more likely we are to identify a superior plant,” he concludes.

By Christie Delfanian

Pictured left: At center, Sunish Sehgal inspects a wheat plant while a student observes.



"We think these fungi can increase the biomass production of bioenergy crops and the yield of food crops..."

Plant and fungi interactions may offer new plant production possibilities for the future

*Heike Bücking, Professor, Department of Biology & Microbiology
2015 Outstanding Researcher, College of Agriculture & Biological Sciences*

DIGGING INTO THE UNDERGROUND world of mycorrhizal fungi is the focus of international research being conducted by professor Heike Bücking in SDSU's Biology and Microbiology Department. Gaining better understanding of the mutually beneficial relationship between plants and fungi could aid future crop production efforts and enhance agricultural sustainability.

For her work studying these interactions in food and bioenergy crops including wheat, corn, soybeans, alfalfa, clover and perennial grasses, such as prairie cordgrass, Bücking was recognized as the outstanding researcher for the College of Agriculture and Biological Sciences at the 2015 Faculty Celebration of Excellence.

Approximately 65% of land plant species form relationships with arbuscular mycorrhizal fungi, sharing carbohydrates with fungi that colonize their roots, according to Bücking. In exchange, these fungi provide plants with nitrogen and phosphorous as well as the trace elements of copper and zinc.

Additionally, these fungi appear to protect plants from environmental stresses, such as drought, salinity and heavy metals, and diseases. Bücking reports, "All the stresses that a plant can potentially be exposed to are generally improved by mycorrhizal interactions."

As a result, Bücking explains, "We think these fungi can increase the biomass production of bioenergy crops and the yield of food crops and do so in a more sustainable and environmentally friendly way."

Her research has been supported by the National Science Foundation, South Dakota Wheat Commission, Sun Grant Initiative, South Dakota Soybean Research and Promotion Council, the U.S. Department of Energy Joint Genome Initiative and the USDA National Institute of Food and Agriculture through the South Dakota Agricultural Experiment Station. This work involves collaboration with researchers at the Vrije Universiteit in Amsterdam and the University of British Columbia as well as Agricultural Experiment Station researchers. Five doctoral students, two master's students and three undergraduates work on this research.

Going forward, Bücking notes the challenge is to figure out which fungi will most benefit specific crops and under which environmental conditions.

Her research has shown that although a host plant is colonized by multiple fungal species simultaneously, the plant knows exactly where certain benefits are coming from. "The host plant can distinguish between good and bad fungal behavior and allocates resources accordingly," she explains, noting that the host plant transfers anywhere from 4 to 20% of its photosynthetically fixed carbon to mycorrhizal fungi.

Conversely, these fungi also form common mycorrhizal networks that give them access to multiple hosts. Her research showed that when host plants were shaded and thus decreased their carbohydrate allocation, fungi responded by reducing their nutrient share.

"Despite depending on their hosts for reproduction, fungal partners can thereby retain their bargaining power," she says.

In addition, she and her collaborators have found that some fungi are more cooperative than others. For example, Bücking and her collaborators evaluated the relationship between alfalfa and 31 different isolates of 10 arbuscular mycorrhizal fungal species. They then classified the fungal isolates as high-, medium- or low-performance isolates. The researchers found that high-performance isolates increased the biomass and nutrient uptake of alfalfa by more than 170%, while the low-performance ones did not have any effect on growth.

However, those that benefit one crop may not provide the same nutrients or benefits to another crop species, she cautioned. "Even different isolates of one fungal species can behave differently," she notes.

Researchers have much to learn about the complex relationship between host plants and mycorrhizal fungi, Bücking admits. "To maximize the nutritional benefits for the host – particularly food and bioenergy crops – we need to better understand how nutrient transport is regulated and controlled."

Once scientists unravel the secrets of this ancient relationship, producers may one day be able to seed the appropriate fungi on a particular crop, thus reducing fertilizer needs.

By Christie Delfanian



Targeting Emerging Diseases

Plant Pathologists Working To Better Manage Soybean & Sunflower Diseases

SOUTH DAKOTA FARMERS are dealing with two emerging fungal diseases — sudden death syndrome in soybean and Phomopsis stem canker in sunflowers. Fungicides are largely ineffective, so farmers must rely on changes in management practices and selection of resistant varieties to reduce their losses, according to plant pathologist Febina Mathew. The Agricultural Experiment Station researcher, who came to SDSU in August 2014, leads multiple projects designed to help producers manage these diseases.

Sudden death syndrome in soybeans did not impact South Dakota farmers until 2013. However, Iowa soybean producers have experienced yield losses due to the disease for nearly a decade.

Moist soil conditions and cool weather contributed to an increase in sudden death syndrome. A survey of 200 South Dakota fields in 22 counties showed that approximately 30 fields in 18 counties had signs of sudden death syndrome. However, Mathew notes, only a few of the more infected fields had low to moderate yield losses.

The pathogen infects plants through the roots, slowly releasing its toxin over time, Mathew explains. It affects the roots and eventually causes yellowing and then browning of the leaves.

In addition to *Fusarium virguliforme* that causes sudden death syndrome, SDSU doctoral student Paul Okello identified nine *Fusarium* pathogens in the field samples and determined that *Fusarium proliferatum* was the most aggressive. His

findings agreed with those of the other researchers in Kansas and Canada.

“We are on the right track,” Mathew says. Now Okello is screening soybean varieties for resistance to multiple *Fusarium* pathogens. In addition, Okello will assess whether soil nutrients, such as potassium, increase the susceptibility of soybean plants to *Fusarium*, particularly in relationship to soybean cyst nematode.

Mathew is working with SDSU Extension plant pathologist Emmanuel Byamukama and entomologist Adam Varenhorst, as well as U.S. Department of Agriculture research agronomist Shannon Osborne and Iowa State University soybean breeder Asheesh Singh for Okello’s study.

Phomopsis stem canker was identified as one of the National Sunflower Association’s top research priorities in 2010 when outbreaks occurred in Minnesota, North Dakota and South Dakota, where 75% of sunflowers are grown. As part of her dissertation research at North Dakota State University, Mathew found both *Phomopsis* stem canker pathogens — *Diaporthe helianthi* and *Diaporthe gulyae* — in South Dakota sunflower fields. Though *Diaporthe gulyae* acts more quickly, both can lead to lodging and reduced yields.

“We’re not sure how it got into South Dakota,” says Mathew. However, because the fungus overwinters on plant residue, the use of no-till, in combination with weather conditions, may have contributed to disease development.

Through National Sunflower Association funding, Mathew is working

Pictured: Assistant professor Febina Mathew and Master’s student Taylor Olson inoculate sunflower seedlings with one of the pathogens that cause *Phomopsis* stem canker.

with Extension plant pathologists Sam Markell from NDSU and Bob Harveson from the University of Nebraska-Scottsbluff to evaluate possible fungicides and host genetics. SDSU Master’s student Taylor Olson has identified one sunflower variety line that has resistance to *Phomopsis* stem canker.

To deal with emerging plant diseases, Mathew says, “It is important to either develop new strategies or evaluate current management recommendations for their efficacy. A plant disease can emerge due to reasons such as the introduction of a new pathogen within a species and availability of susceptible crop acreage. To evaluate disease management strategies for their efficacy, I use diagnostic molecular tools. Ultimately, providing effective disease management options to producers are necessary to protect crop yield and minimize economic damage.”

By Christie Delfanian

Funding for the soybean research is from the South Dakota Soybean Research and Promotion Council and the North Central Soybean Research Program. Funding for the sunflower research is from the National Sunflower Association and the USDA National Institute of Food and Agriculture Hatch funds through the South Dakota Agricultural Experiment Station.



Compelling New Crop

Carinata Offers Potential For Crop Diversity, Livestock Feed & Biofuels



“WE HAVE HIGH HOPES FOR IT.” That’s how SDSU professor Bill Gibbons describes carinata, a new crop being researched for its promising potential in South Dakota.

The oil from carinata seeds can be used to make biobased fuels, such as diesel and jet fuel, that are identical to their petroleum counterparts. This means they can be used without modifications to existing engines, and can be dispensed through the current petroleum fuel infrastructure. Biofuels with these characteristics are called “drop-in” fuels.

Gibbons, who specializes in industrial microbiology, says there is growing interest – and demand – in this type of “green” biofuel.

The Navy reached out to SDSU and other universities about four years ago to express interest in developing more



sustainable and distributed sources of diesel and jet fuels. “They are seeking ways that the United States can move away from a high level of dependence on petroleum fuels and the limited geographic area (Gulf coast) in which most petroleum is refined. Hurricane

Katrina demonstrated to the military that our petrochemical refining industry is susceptible to supply disruptions...It can be a tenable situation,” Gibbons notes.

To that end, the Navy has set a goal of deploying the “Great Green Fleet” in 2016, in which ships and aircraft from

a carrier strike group will operate on a 50:50 blend of petroleum and biofuels. Research efforts are focused on ensuring that biofuels created from carinata will be included – including a SDSU project working with the Navy and Agrisoma Biosciences, Inc. (the Saskatchewan company commercializing carinata varieties) to conduct a demonstration with the Navy's Blue Angels Precision Flight team in their 2016 performance in Sioux Falls.

As an additional market, European airlines have committed to purchasing carinata seed from the 2016 crop, and

trials across the state, including some on private producer farms.

"This is a new crop, so we are conducting variety evaluations and analyzing what is necessary to optimize the agronomic conditions for carinata," Gibbons explains. Factors being evaluated include timing to plant, row width, nitrogen recommendations, herbicide tolerance, insects, and crop rotations. Crop production costs and returns are being assessed by SDSU economists, while engineers from South Dakota School of Mines and Technology are performing life cycle analysis to assess

that can be a feed source. According to Gibbons, presently SDSU researchers are conducting meal utilization trials to evaluate its use in the beef, dairy, and swine industries. Fish trials are also being conducted to determine opportunities for aquaculture. Technologies to improve qualities of the carinata meal co-product are being looked at as well.

All total, Gibbons says nearly 20 researchers across the state are collaborating on carinata research and have optimism for the crop's future.

He states, "We look at this as a new rotational crop. If we can get producer

More About Carinata

The yellow-flowered carinata plant is a brassica, which is a genus of plants in the mustard family. Carinata is sometimes called Ethiopian mustard. A more familiar brassica crop is canola, which is commonly grown in Canada, Montana and North Dakota. Many farmers in these regions who are familiar with growing canola have also started to grow carinata. It's estimated North Dakota and Montana farmers planted about 6,000 acres of carinata in 2015.

SDSU's Bill Gibbons shares that carinata was chosen for biofuel production, not only for its high oil content, but also because it does not compete as a crop for human consumption. "It tastes terrible to humans, but is perfect for biofuel production," he shares.

Gibbons explains that the primary oil from carinata is a 22-carbon long fatty acid chain (erucic acid), which can be split to create two 11-carbon chains. "This is perfect for jet fuel. With carinata you get two fuel molecules out of one. With shorter chain length oils (such as soybeans) you just get one 11-carbon fuel molecule."

Although carinata is best suited to semi-arid conditions, it is also being grown in Alabama, Georgia and Florida as a winter crop that is planted in November and harvested in April.

will ship it to Europe for crushing and conversion into jet fuel. As the crop becomes more available in the future, Gibbons anticipates domestic American airlines will also provide a market, and eventually, carinata-derived diesel could be offered for use by everyday consumers.

Gibbons says, "The technology for extracting the oil from carinata is known, and the technology to convert the oil to fuel exists." As well, the market exists. Now, the final hurdle is to learn more about the agronomic production of carinata in South Dakota to help farmers successfully grow the crop.

And that is exactly what SDSU has been doing over the past four years. SDSU has been collaborating with Agrisoma Biosciences Inc. to explore carinata as a new biofuels crop in the state. Funding support has been provided from state and federal sources, and SDSU researchers have been conducting field

environmental sustainability.

Gibbons calls carinata, which is suited to a drier climate and marginal lands, "the perfect fit for western South Dakota." He reports that it works well in rotation with wheat, sunflowers, milo or sorghum. Yields have produced 2,000 pounds per acre in test plots at Dakota Lakes Research Farm east of Pierre.

Additionally, research indicates that the carinata plant, which is a relative of the mustard species, produces an allelopathic compound that kills nematodes in the soil – which in turn appears to boost wheat yields on those acres the following year.

"For 2016, we will pursue a significant expansion in growing the crop in South Dakota," Gibbons says.

And, there's more good news about carinata. A co-product of the carinata refining process is a high protein meal

buy-in and carinata acreage expands, I see it [having an impact] like ethanol in Eastern South Dakota. It has the potential to buffer the economy because producers have two markets for their crop – feed and fuel."

Gibbons believes in the future the opportunity to build a carinata extraction and processing facility in the state may even exist.

He adds, "Western South Dakota has never had this kind of opportunity for diversity of agriculture....And, with a high protein feed source, it could boost their cattle industry."

All total, Gibbons is excited for this crop's future. It may represent a new "Gold Rush" for the state.

By Kindra Gordon

WINTER COLLEGE NEWS

Binnewies Family Donates Land To Benefit SDSU

Long-time supporters of SDSU, the Binnewies family has donated two quarter sections of land to the university for research and education purposes. The gift was made in the spring of 2015 and will benefit future South Dakota Agricultural Experiment Station (SDAES) research efforts.

Daniel Scholl, director for the SDAES, says, "This land will be a permanent resource to support the research and teaching mission of the College and the SDAES. It provides diversity of location for development of new varieties of small grains, and supports our growing livestock teaching and research programs." He notes that future research and education efforts at the site will focus on sustainable farming and conservation systems.

Located near Lake Campbell and about 17 miles from the Brookings campus, the land was the foundation for the Binnewies family farm. A majority of the land is in grasslands and wetlands, providing a haven for wildlife habitat. About 200 acres are utilized as cropland and are being used for seed production, reports Jack Ingemansen, who is superintendent of the SDSU Foundation Seed Stock Division.

Ingemansen notes that having a location away from campus has allowed for increased diversification for feed and seed production. SDSU had the opportunity to lease the property for crop production during the 2014 growing season.

Mike Barber, development director with the SDSU Foundation, expresses appreciation for the family's generous donation, saying, "SDSU is grateful for the donation of this land for the benefit of education and research for future generations. The support of SDSU's donors is what continues to make a positive difference for students and our state."

Bob Binnewies shares that his grandparents and parents both placed a very high value on education – and on the land. The donation was prompted by their interest in their farm having a permanent impact on higher education at SDSU, and in particular helping to generate knowledge and train students in approaches that conserve the productivity of the land.

Pictured: Siblings Bill Binnewies, Carolyn Gastellum, and Bob Binnewies have gifted land to SDSU for future education and research efforts.



Announcing New Faculty

Mark Messerli and **Natalie Thiex** have recently joined SDSU's Department of Biology and Microbiology. Messerli is an assistant professor specializing in cell signaling, polarity and tissue repair. Thiex is an assistant professor with a focus on growth factor signal transduction and vesicular trafficking.

New instructors in the Department of Biology and Microbiology include **Mandy Orth**, who is coordinating the introductory biology labs, and **Kumar Mulangi**, who teaches human anatomy and physiology at the University Center in Sioux Falls.

Joining SDSU's Veterinary and Biomedical Sciences Department during the past year are **Angela Pillatzki**, an assistant professor of veterinary pathology and immunohistochemistry with special interest in infectious diseases; **Joy Scaria**, an assistant professor of infectious disease genomics and **Diego Diel**, an assistant professor of virology.

In spring 2016, the Dairy Science Department will add two new faculty members. **Sergio Martinez-Monteguado**, currently a post-doc at The Ohio State University, will join the department as an assistant professor in dairy manufacturing, and **Johan Osario**, currently a post-doc at Oregon State University, will join as an assistant professor in dairy production. Joining SDSU's Plant Science Department recently are **Qin Ma**, assistant professor of bioinformatics, **Michelle Ohrtman**, plant science lecturer, and **Jiyul Chang**, lecturer specializing in precision ag, GIS and remote sensing.

Dakota Lakes Research Farm Marks 25th Anniversary

The Dakota Lakes Research Farm, located 17 miles east of Pierre along Highway 34, celebrated its 25th anniversary in September 2015. The farm was started in 1990 by a group of area producers, with SDSU as a research collaborator. Much of the farm's early focus was on crop rotations and no-till management, with recent efforts studying cover crops as well.

SDSU professor and farm manager Dwayne Beck reports that for the future, the Dakota Lakes Board of Directors has made integration of livestock into farming operations a priority. Currently, a project is underway developing a self-propelled grazing cell, in which cattle are placed in pens that move around on the landscape – and the cells are remotely monitored.

The mission of the Dakota Lakes Research Farm is to identify, research, and demonstrate ways to strengthen and stabilize the agricultural economy. *For more information visit www.sdstate.edu/aes/stations/dakota-lakes/index.cfm.*

Special Recognition



David Schingoethe, SDSU Dairy Science Department Distinguished Professor Emeritus, was recently recognized with a National Dairy Shrine Pioneer

award. Schingoethe joined the SDSU Dairy Science Department in 1969 and retired in 2011. Throughout his career, Schingoethe made major contributions to dairy education through teaching and mentoring of undergraduate and graduate students, and to dairy farmer groups. Recognized as a top dairy cattle nutrition researcher in the country, he received numerous grants from a diverse range of funding sources, including the National Science Foundation. His publications include more than 140 peer-reviewed papers. Schingoethe was recognized during World Dairy Expo and will have

his portrait displayed at the National Dairy Hall of Fame and Museum in Fort Atkinson, WI.



Don Lewis, who received his Ph.D. from SDSU in 1976 while working with Lowell Slyter and Rick Wahlstrom, was awarded the Animal Science Department's

Distinguished Alumni Award during an awards banquet in Brookings in September. Based in Lincoln, NE, Lewis is one of the most highly respected swine reproductive physiologists in the world. Swine producers utilize the 'Lewis System' that he developed for managing artificial insemination breeding programs. Lewis has consulted with more than 1,230 individual swine operations in the United States and 15 foreign countries. His career has included professorships

at North Carolina State University, and the University of Nebraska-Lincoln, and he has led research programs at USDA's Meat Animal Research Center in Clay Center, NE.

Erin Doherty, won the American Society of Animal Science (ASAS) national undergraduate poster competition at the ASAS's 2015 Joint Annual Meeting in Orlando in July. Doherty, an SDSU senior from Luverne, MN, is pursuing a biotechnology major and chemistry minor. She is the first SDSU undergraduate to win the poster competition, which showcases student research from universities nationwide. Her research investigated ways to increase the efficiency of how starch is digested in the small intestine of cattle, and is the result of a collaborative project under the guidance of Derek Brake, SDSU Assistant Professor of Ruminant Nutrition, and George Perry, SDSU Professor and SDSU Extension Beef Specialist.

College of Agriculture and Biological Sciences



Nonresident Dakota Returns Tuition Program

Starting fall 2015, incoming freshmen and transfer students who are children of South Dakota State University alumni are eligible for **in-state tuition!** Freshmen must have an ACT composite score of 20 or higher (SAT of 950 or higher). Transfer students must have a GPA of 2.5 or higher.

For more information:

Email: sdsu.admissions@sdstate.edu

Phone: 1-800-952-3541



Habitat Helpers

Fish Ladders Help Reconnect Stream Habitat

“DID YOU HEAR ABOUT THE FISH THAT USED A LADDER?” At first that may sound like a bit of a fisherman’s tale, but there’s no foolery with this story. SDSU natural resource management researchers have developed a patent-pending fish ladder to help small fish better access their habitat.

Associate professor Katie Bertrand, associate professor Brian Graeb and graduate student John Lorenzen have designed and tested the fish ladder device to help small fish overcome the challenges of moving upstream through culverts when water levels are low. The patent-pending fish ladder will help minimize the impact that roadways have on fish habitat, and ultimately enhance fish populations by preserving connectedness to their habitat.

“The ladder works for nearly all small-bodied fish,” Bertrand explains. The researchers field tested the ladders in eastern South Dakota and the Black Hills this summer through a \$112,086 State Wildlife Grant from the South Dakota Department of Game, Fish and Parks, with partial funding through the U.S. Fish and Wildlife Service. The fish ladder project was also supported by USDA National Institute of Food and Agriculture Hatch funds through the South Dakota Agricultural Experiment Station.

BRIDGING GAP FOR SMALL FISH

Bertrand explains what prompted the development of the fish ladders, saying, “When the water gets to the back side of the culvert, it falls off and scours out a pool on the downstream side. The distance from the lip of the culvert to the pool below can be anywhere from a few inches to several feet. When water levels drop during the summer months, moving upstream becomes impossible for small bodied fish, such as minnows, darters and madtoms.”

“They don’t have the physiological ability or strength to jump up that waterfall,” she says. “You’ve put a wall in their path and fragmented their habitat.”

“Small fish might move 1 to 2 miles within a few days,” Bertrand notes. During the design phase, the researchers tested their fish ladder design in the lab with 20 small fish species. Only those species that tended to sit on the bottom of the stream pool had difficulty using the ladders.

Last summer Lorenzen installed the fish ladder at 19 sites – nine in eastern South Dakota and 10 in western South Dakota and the Black Hills, in particular.

The Black Hills National Forest is one of the most densely roaded national forests in the country, according to South Dakota Department of Game, Fish and Parks fisheries biologist Jake Davis. That fragmentation of the habit for native as well as sport fish is a concern for wildlife managers.

The ladders were deployed in culverts that ranged from 2 to 12 feet in diameter with the drop-off distance from the culvert lip to the stream averaging 17 inches. Ladders remained in place for five days, with the researchers collecting fish from a funnel trap just above the ladder each day.

Pictured left: Undergraduate student David Ahrens (in blue) and graduate student John Lorenzen stand near an installed fish ladder.



Pictured: Associate professor Katie Bertrand watches as graduate student John Lorenzen and undergraduate student David Ahrens install a fish ladder in a culvert on Slip Up Creek near Renner. The ladder allows small-bodied fish, such as minnows, to swim upstream and increases the connectivity of their habitat.

Statewide, 23 species of small fish passed through the ladders. Passage rate for ladders in eastern South Dakota was more than 28 fish per day, while West River numbers were lower averaging a little more than one fish per day. The highest number of small fish accessing the ladder in a single day was nearly 740, according to Lorenzen. Nearly 50 brook trout also used the ladders.

The highest usage occurred among carmine shiners, with Lorenzen recording 609 passing through the ladders in the northeastern corner of the state on the Bois De Sioux River. The species is considered imperiled because of its rarity and eastern South Dakota is the western most part of its range, according to the South Dakota Game, Fish and Parks website.

INCREASING FISH HABITAT

“The ability to move at certain times of year and have specific habitat available impacts the basic biology of these fish,” Davis points out. “The ability to pass through culverts would improve fisheries management by increasing the amount of habitat available to them.”

Davis envisions state wildlife agencies cooperating with other federal and non-government agencies to prioritize locations that would benefit certain species on specific watersheds. “It could make the complete watershed available to all the fish species in it,” Davis says. As Bertrand points out, “It’s about reconnecting populations.”

By Christie Delfanian

Studying Stewardship

Oak Lake Field Station Provides Array Of Research & Education Opportunities

WATER QUALITY. Pollinator habitat. Biomass for cellulosic biofuels. Inventorying and managing natural resources – from native plants to aquatic invertebrates. There are an array of topics that are important and impactful to the future stewardship of South Dakota – and the world's – resources.

Scientists at SDSU are actively engaged in studying these topics and the Oak Lake Field Station located 22 miles northeast of the SDSU campus at Brookings provides a valuable environment for this research.

"We have a lot of projects going on and the research efforts represent a diverse mix of agricultural and biological studies. Most of the work being done has a management focus and impacts private landowners and natural resource managers," reports Nels Troelstrup, who has served as the station's director for the past 22 years. The Oak Lake Field Station is a 570-acre facility featuring grassland, oak forest, wetland and lake environments in the heart of the Northern Plains – and amidst the vast cropland of eastern South Dakota.

Presently, the field station hosts university research involving faculty and students from several SDSU departments. Projects represent biofuels development, biodiversity of prairie communities, fire ecology, and stream ecology.

One current study is looking at habitat enhancement for pollinators. Experimental plots have been established to evaluate re-establishment of native forbs and grasses in roadside ditches in anticipation of better utilizing these existing areas as beneficial habitat.

Another study being conducted is focused on identifying management methods to reduce the competitiveness of smooth brome grass and promote establishment of native grasses and forbs. "Improving the natural diversity of land is beneficial both in a pasture setting and for small properties where landowners want to improve habitat," Troelstrup points out.

Plots of switchgrass and other native tall grass species are being evaluated for a cellulosic biofuels study. "This research is helping determine biomass production that can be expected from the different



species, and in turn provide good habitat for insects and small mammals," Troelstrup explains.

Troelstrup reports that the biomass plots have been established for three years, and data is continuing to be collected to document the spread and thickening of the grass species, as well as monitoring insect and small mammal populations. "We're interested in the biodiversity. Like many of the projects we do, this is a great example of research that involves both agricultural and ecological outcomes."

More than half of the research projects initiated at Oak Lake Field Station involve a water quality aspect. One of the multi-year projects underway, with funding from the Environmental Protection Agency, has focused on assessing invertebrates and fish in streams across the state and establishing benchmarks for management.

Troelstrup explains that this study is inventorying stream conditions, watershed modeling, water chemistry, and habitat. "The end goal is to develop a set of sites as control sites that best depict the ideal stream characteristics for that region. The information we're generating is being used by the state to set management goals for water quality, habitat and biological integrity," he explains.

Streams in eastern and central South Dakota have already been inventoried. An inventory of Black Hills streams is already in the planning stages.

Another multi-year project being initiated at Oak Lake Field Station and then expanding statewide will be an effort to assemble a natural history collection of South Dakota aquatic invertebrates, including freshwater clams. The project is being conducted with funding from South Dakota Game Fish & Parks and South Dakota's Department of Environment and Natural Resources. Part of that effort also includes a study of freshwater clams in South Dakota. "There has never been a statewide survey done, so we have no idea what's even here. Freshwater clams are some of the most endangered species on the planet and it will be important to determine their abundance and habitat," explains Troelstrup.

South Dakota researchers are not the only ones who benefit from the outdoor oasis provided at the Oak Lake Field Station. The station's diverse ecology has also attracted researchers from universities in Minnesota, Oklahoma, Texas, and most recently Indiana.

Troelstrup explains that as a member of the Organization for Biological Field

Pictured left: The Principles of Ecology Lab is taught entirely at the Oak Lake Field Station during day-long Saturday sessions in September and October. Associate professor Xu Lan (front row, far left) teaches the course. **Pictured right:** Student Josh Young (standing) and Dr. Xu Lan collect a soil core sample for a research project evaluating management to reduce competitiveness of smooth brome grass stands.

Oak Lake Provides Student Classroom, Too

Research isn't the only focus at the Oak Lake Field Station. "We have a strong education component and because of our close proximity to Brookings we are integrally involved with campus," says Oak Lake Field Station Director Nels Troelstrup.

He continues, "We have classes taught here, training workshops...lots of education going on."

More than a dozen university courses utilize the field station for their curricula, including ecology, biology, introduction to range science and a Native American Writer's Retreat.

In May 2016, the field station will host a new "field techniques" course to be held annually and required for four natural resource majors. Troelstrup explains that the one-week course will provide practical and hands-on training ranging from collecting water samples to animal trapping and plant identification.

"These are skills these students will need for future employment with state and federal natural resource agencies. The course will provide the hands-on experience that would be difficult to offer in a traditional classroom setting," explains Troelstrup. About 80 to 100 students will be involved with the course annually.

In addition to SDSU courses, the Oak Lake Field Station facilities are also used for conferences, retreats and community service events. A weeklong retreat for Native American writers from across the country is one of the longest standing programs at the station. Several local schools utilize the station for field trips, and a high school summer science camp facilitated by SDSU faculty and graduate students is also offered each June.

The Oak Lake Field Station is open May through October to the general public. Groups may reserve use of the grounds and dining hall for a modest fee.

Stations, other researchers become aware of what the Oak Lake Field Station offers for research opportunities. Membership in the organization has also garnered additional funding for projects, including National Science Foundation funds.

During the summer of 2015, a Purdue researcher collected data for a soundscape study focused on prairie habitat. The Oak Lake Field Station was selected as one of the international sites, along with other locations in the United States, Russia and South America.

"The sound fingerprint is a different way of evaluating the human footprint on the environment," Troelstrup explains.

All total, Troelstrup says projects such as this depict the value of Oak Lake Field Station as a place to study and learn about issues that affect the world today and in the future. He concludes, "We provide a place in the Northern Plains where research can be conducted related to local needs, as well as the broader science needs that exist."

Editor's Note: In addition to the Oak Lake Field Station, South Dakota Agricultural Experiment Field Stations are also operated in South Dakota near Cottonwood, Buffalo, Pierre, Beresford and South Shore.

By Kindra Gordon

Honing In On Habitat

New Effort Aims To Develop Habitat Plans For State Facilities



INTERMINGLED AMONG SDSU'S facilities – both on campus in Brookings and at Research Field Stations statewide – are lands that provide important habitat for wildlife, birds, pollinators and aquatic species.

As an example, Brian Graeb, an associate professor in the Natural Resource Management Department, points to the Six Mile Creek area that borders the north side of campus in Brookings which provides riparian habitat, pollinator habitat and is also habitat for the Topeka Shiner, an endangered freshwater fish species.

"We have these important resources right here on campus and across the state, and we are putting new emphasis on ensuring a framework is developed

to establish best management practices for conservation on those lands into the future," Graeb explains.

Through an integrated approach that involves faculty and students "habitat management plans" are being developed for lands that are intermixed or adjacent to campus, as well as the teaching and education units – including the Cow-Calf, Dairy, Swine, Sheep, Horse and Feedlot facilities – and the six South Dakota Agricultural Experiment Field Station locations statewide. Those locations include Antelope Range & Livestock Field Station near Buffalo, Cottonwood Range & Livestock Field Station near Philip, Dakota Lakes Research Farm near Pierre, Southeast Research Farm near Beresford,

Oak Lake Field Station near White, and Northeast Research Farm near South Shore.

The effort is being lead by SDSU's Natural Resource Management Department including faculty members Brian Graeb, Mike Brown, Katie Bertrand and Troy Grovenburg.

Grovenburg, who teaches an undergraduate habitat management course, initiated the first steps for developing a habitat management plan for the Six Mile Creek habitat during the Fall 2015 semester by having students design plans for the terrestrial component of that land. As well, students in the Fall 2015 Advanced Fisheries Management course taught by Graeb developed management recommendations for the aquatic resources.



Those are just initial steps. The goal is to develop a framework for habitat management that can be applied at the teaching units and research field stations statewide. Steps at each location will include inventorying resources, considering the landscape, and then identifying and addressing challenges that exist.

Both undergraduate and graduate students will have opportunities to be involved as these habitat management efforts are expanded, and to conduct research on these areas in the future. Graeb and Brown anticipate research opportunities for postoperative measurements and monitoring as well as landscape scale studies at multiple sites.

Looking to the future, the intention is that these efforts will enhance water quality, species habitat, and fish and wildlife biodiversity. Graeb notes that a long tradition of agricultural production exists on South Dakota lands, including lands managed by the university. By designing and implementing habitat management plans for SDSU-operated facilities, Graeb says the hope is to bring a focus to environmental services and benefits as well.

Brown notes that it also provides an opportunity to set an example for private landowners to emulate. He says, “Our efforts will provide an opportunity to demonstrate and expose producers to how we can create better environment to utilize areas for better purposes such as pollinator

Pictured: Students conduct various stream collection techniques to inventory aquatic species. Similar skills are being employed for development of habitat management plans on Six Mile Creek near campus.

habitat and wildlife. We can always do better [on the land].”

Brown concludes, “Ultimately, we want to encourage a holistic approach to managing lands with conservation seamlessly integrated with production into management plans.”

Funding for the habitat management planning effort is through USDA National Institute for Food and Agriculture funds to the South Dakota Agricultural Experiment Station.

By Kindra Gordon

Dairy Science Savvy

Spray-Drying Research Is Helping Optimize Formulations For Milk Powders And Dairy Ingredients

AUSTRALIA AND SOUTH DAKOTA are on opposite sides of the world, but collaboration between South Dakota State University dairy scientists and chemical engineers in Australia will make developing new dairy ingredients with specific functional properties easier.

SDSU dairy researchers are using a bench-scale single-droplet spray dryer to determine the exact drying parameters for an ingredient with the desired functional properties. Spray drying is a method of producing a dry powder from concentrated liquid milk by spraying it into a stream of hot air.

SDSU's data on the drying behavior of different ingredients and formulations is then being utilized by associate professor Cordelia Selomulya and her team at Monash University near Melbourne, Australia, to develop a computational fluid dynamics model to predict the range of drying parameters needed to produce a powder with those properties in a spray dryer.

"Our expertise is in manufacturing and functionality; theirs is in engineering and modeling," says professor Lloyd Metzger, who leads the SDSU research team. "It's an ideal collaboration because our areas of expertise are complimentary."

The project was begun by former SDSU assistant professor Hasmukh Patel, who is now a senior principal scientist at Land O'Lakes in Minneapolis.

The SDSU portion of the three-year project, which began in 2014, is supported

by a Dairy Management Inc. grant of more than \$250,000. The research focuses on optimizing spray-drying conditions for milk powders and dairy ingredients, such as whole milk powder, whey and milk protein concentrates and isolates and infant formula. Doctoral student Hiral Vora and other SDSU dairy science staff are working on the project.

When it comes to spray-drying, any number of conditions can affect powder properties, including the characteristics of the material being dried, the nozzle type and amount of pressure behind the nozzle, the fluid pre-heat temperature and the air inlet and outlet temperature, says Metzger.

Additionally, the desired powder properties will vary for different products. For instance, in an application like coffee creamer, he points out, the powder must dissolve very quickly in hot coffee and it may be required to foam. In other applications like infant formula, the density of the powder is critical to ensure that each scoop of powder has the correct nutrient content.

The dairy industry now uses trial and error or past experience to adjust drying conditions to achieve the desired powder characteristics, Metzger explains.

This approach assumes what happens with a small batch using a lab-scale or pilot-scale dryer will work on a larger scale, according to Selomulya. However, she cautions, "both are complex systems in their own right, so the drying history

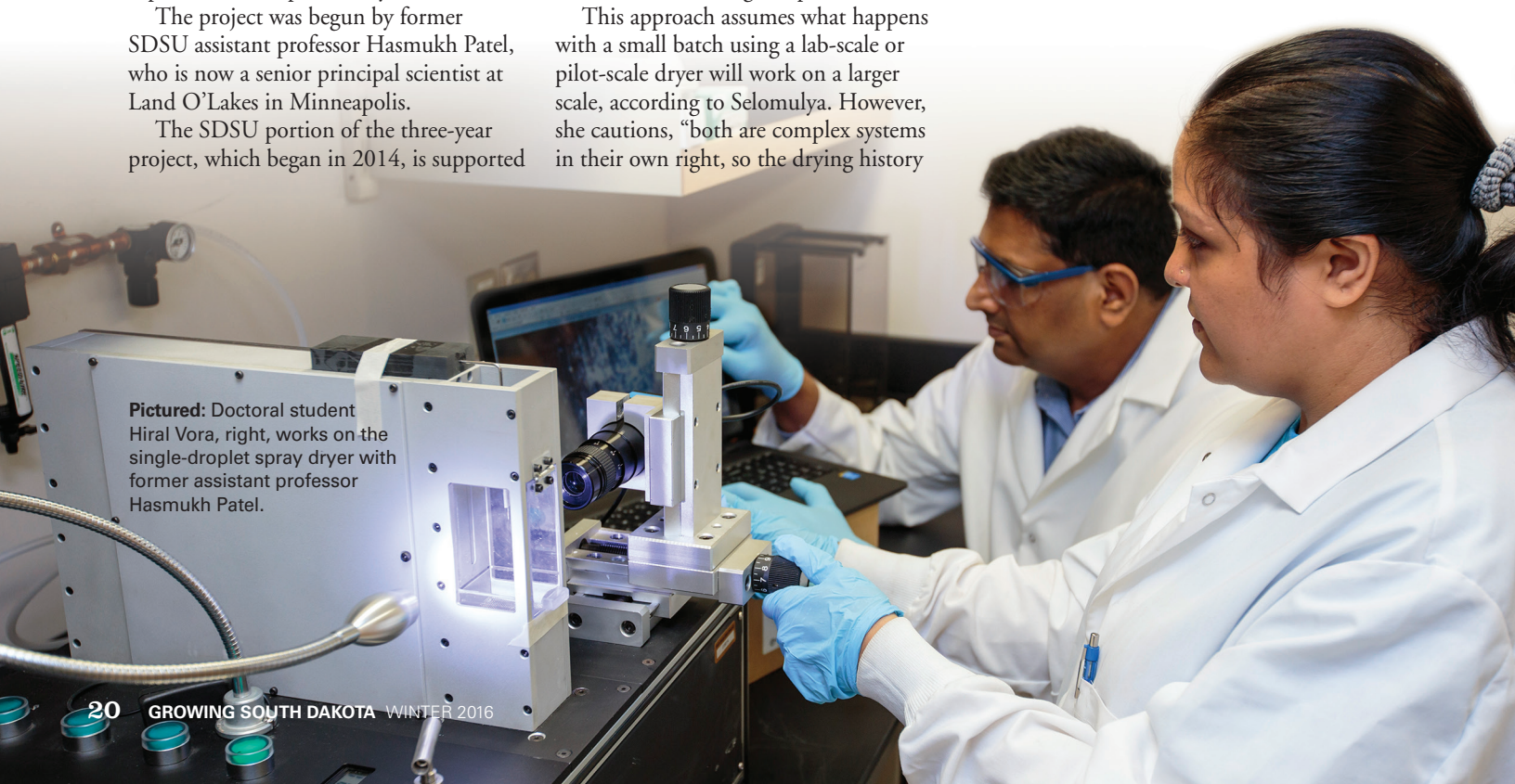
will be different for each dryer. With the variation of feed formulation in dairy, trial and error is not an effective approach."

Selomulya and her team will calculate the drying rate of the material using experimental data, such as changes in mass, droplet temperature and size, along with morphological changes, such as skin formation, from the single-droplet dryer combined with a reaction engineering modeling approach. The results will then be used in a computational fluid dynamics model to predict what will happen inside an industrial spray dryer.

"It's all about trying to simulate on a small scale with the single-particle dryer and relate that to what happens in the big dryer," Metzger says. The semi-commercial-scale dryer at the Davis Dairy Plant will be used to validate the methodology and scale up the models developed.

This collaborative effort promises to streamline the process of changing formulations and developing new dairy ingredients—and that could translate into increased efficiency and better dry ingredient products for the dairy industry.

By Christie Delfanian



Pictured: Doctoral student Hiral Vora, right, works on the single-droplet spray dryer with former assistant professor Hasmukh Patel.



Saving Our Soil

SDSU On Frontlines To Address Saline & Sodic Soil Identification And Management



HIGH SALTS in soil is a situation landowners recognize as detrimental to crop production. In fact, a 2012 land assessment conducted by the Natural Resources Conservation Service in the three South

Dakota counties of Beadle, Brown and Spink quantified yield losses at \$26 million per year due to high salts in soils. Statewide it is estimated saline and sodic conditions impact about 5 million acres – one-tenth of the land in South Dakota.

The trend of affected soils in the state has unfortunately been increasing over the past two decades due to a combination of factors, according to soil biogeochemistry professor David Clay and soils and agronomy lecturer Cheryl Reese. Both individuals work with SDSU's Plant Science Department.

Clay explains that climate change in the form of higher spring rainfall and warmer spring temperatures has extended the growing season across the northern tier of the state. In response to more favorable climatic conditions, more land has been devoted to producing annual crops. Because of these changes, the water table has moved closer to the surface bringing salt with it.

Saline and sodic soils are fundamentally different: saline soils are caused by an increase in calcium and magnesium; whereas sodic soils are caused by an increase in sodium, Reese notes.

Typically, soil tests from commercial labs can help landowners identify if high salts are becoming an issue in their fields. However, due to a recent change in soil testing and reporting methods, a discrepancy has been discovered in the results that farmers receive.

"The soil testing labs are using a different technique, so the data producers receive may not indicate a problem, when in reality, landowners do have a salt problem," explains Clay.

He adds, "This very serious problem is not widely known among farmers."

Clay and Reese underscore that the current situation is not anyone's fault, it's simply a result of a change in the way the testing is done and reported, so the numbers provided to producers need to be interpreted differently. Basically the EC

values on the soil test report need to be multiplied by 2.14 to correct the values.

To address the issue and assist landowners, SDSU has focused on an extensive producer education effort in farming areas where saline and sodic soils are most prevalent. Reese coordinated landowner meetings in Redfield, Pierpont, Pukwana and White Lake, reaching more than 500 farmers during the summer of 2015, and more meetings will be held during the 2016 growing season.

She reports, "There has been a lot of interest in these meetings and this topic. Producers want to take care of the land. They are asking 'How do I do better?'"

Clay adds, "The key to resolving this will be communication." He shares that SDSU researchers and Extension specialists are working with the Natural Resources Conservation Service and the South Dakota Corn Utilization Council to conduct research on saline and sodic soil mitigation as well as to provide resources and information to producers. "It's been a very collaborative project," he emphasizes.

For landowners, Clay and Reese recommend seeking informed advice to verify and interpret soil test results. If a saline or sodic problem is identified, working with a soil specialist to determine recommended management approaches is important. In situations where high salt soils no longer allow plant growth, planting the area to salt-tolerant, perennial grasses may be the only alternative.

Clay emphasizes that properly managing these lands is essential to reduce erosion and protect water quality of South Dakota's streams and lakes for the future.

NRCS and SDSU are collaborating on research to evaluate what perennial grass species are best suited to high salt areas. As well, research on what soil amendments may help address saline and sodic soils is being looked at.

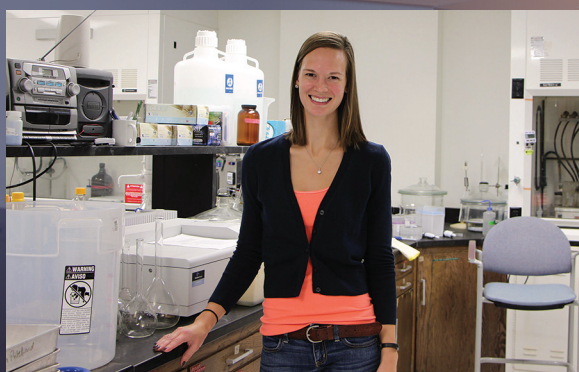
SDSU is also developing a new fact sheet to provide information to landowners and foster understanding related to saline and sodic soil identification and management. A chapter in the iGrow Corn Manual will also be devoted to the topic and will be released in Spring 2016.

Funding for these efforts are being provided from USDA-NRCS, the South Dakota Corn Utilization Council and the USDA National Institute of Food and Agriculture Hatch funds through the South Dakota Agricultural Experiment Station.

By Kindra Gordon

Real-World Results

Undergraduates Gain Experience While Assisting SDSU Research Efforts



THE SOUTH DAKOTA STATE UNIVERSITY COLLEGE OF AGRICULTURE AND BIOLOGICAL SCIENCES has abundant research opportunities available to undergraduate students – allowing students the chance to collaborate with faculty conducting advanced research in their respective fields. There are a variety of funding sources to support undergraduate research, including grants and awards that students can receive. The amount of time that students spend working on research projects varies greatly depending on the length and intensity of the specific research project.

Alex Rogen, a junior Biology/Pre Veterinary major from Brandon, SD, is working on an undergraduate research project titled, “Porcine Reproductive and Respiratory Syndrome virus (PRRSV) whole genome sequencing.”

Rogen is working on completely sequencing the PRRSV genome to look

for variability in areas other than the open reading frame 5 (ORF5), under the guidance of Travis Clement, research associate III in the Animal Disease Research and Diagnostic Lab; Jane Christopher-Hennings, director, professor, and department head of Veterinary and Biomedical Sciences; Dana Rausch, senior microbiologist; and Matthew Dammen, senior microbiologist.

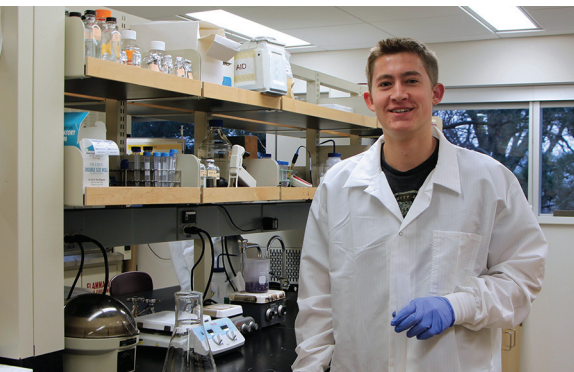
PRRSV is a disease that has a significant impact on the pork industry. “This research will provide insight for better vaccine production, diagnostic tools, cost efficiency, and better herd management,” Rogen explains.

Having a background in research will be beneficial to Rogen as a future veterinarian. “A lot of veterinarians don’t come from a research background, so the knowledge I have gained about gene sequencing and testing techniques will be very helpful,” Rogen says.

Pictured above: Student Olivia Kendall completes lab work for an equine analysis project; **Inset photo:** Student Erin Doherty is studying how starch is digested in cattle’s small intestine.

Travis Clement, Rogen’s mentor in the project, sees many ways that hands-on experience in a lab is helpful to students. “It gives students a basis for knowing exactly how to interpret results, apply knowledge and gain an understanding of research,” Clement says.

Josh Young, a senior Wildlife and Fisheries major from Estherville, IA and Denise Olson, a senior Wildlife and Fisheries major from Portland, OR, are both working on undergraduate research projects studying the effects of mowing as a management method for smooth brome grass. They are working under the guidance of Xu Lan, associate professor in the Department of Natural Resource Management.



Pictured clockwise from lower left: Student Alex Rogen and his research advisor, Travis Clement, work to sequence the PRRSV genome; Jacob Zahler is studying fungi production on bioprocessed soybeans; and Denise Olson, associate professor Xu Lan and Josh Young are completing studies related to management of smooth brome grass.



Young is studying the effects of a mowing treatment on the viability, size and length of smooth brome grass, specifically looking at the effect it has on rhizomes.

Olson is focusing on the effect mowing has on the axillary bud of the grass. She is testing a management method where grass is mown more frequently during a growing season. "If the axillary buds can be decreased, the grass itself can be decreased," Olson says.

Of the benefits research has in preparing students for their future careers, Xu says, "When looking for future employees, many employers look for students with undergraduate research experience because they learn how to manage time and tasks, work under a deadline, and prioritize."

This past summer, Erin Doherty, a senior Biotechnology major and Chemistry minor from Luverne, MN,

became the first SDSU student to win the American Society of Animal Science undergraduate poster competition, which showcases student research from universities nationwide. Her project is entitled, "Inosine 5'- monophosphate increases glutamic acid induced cholecystokinin release from bovine proximal small intestine." She has worked on the project for the past year under the guidance of Derek Brake, assistant professor of ruminant nutrition, and George Perry, professor and extension beef specialist.

Their research is focused on investigating ways to increase the efficiency of how starch is digested in the small intestine of cattle – the findings have the potential to positively impact the entire cattle industry.

Doherty describes the outcome of the interactions that were initiated during their research. "The response we saw can actually increase the amount of starch digestion happening. So cattle are able to utilize all the starch because it is broken down into more readily available molecules that the cattle can use for energy, and therefore they can get more out of their feed".

Olivia Kendall, a senior Animal Science and Biology major from Jordan, MN, is working as the third party in a commercial project on equine analysis titled, "The effect of diet on serum antibody response to vaccine in horses." Third party research is conducted as an unbiased way to evaluate research results. She works under the guidance of Alan Young, professor in the Department of Veterinary and Biomedical Sciences, and Rebecca Bott, associate professor and SDSU Extension equine specialist in the Department of Animal Science.

A commercial company developed and completed a trial to see if their feed

supported immune function in horses and in order to increase reliability, Kendall tested the feed as a blind analysis. Her research could potentially be used as a management strategy to increase horse herd health by supporting the immune system.

"My portion of the project was taking the serum samples and testing them in the lab with an enzyme linked immunosorbent assay (ELISA) test that measures how many antibodies are present in the samples," Kendall says.

Additionally, Kendall says, "Gaining research experience has given me the opportunity to apply my education and what I learn in classes." After graduation, she plans to attend veterinary school with an interest in large animal medicine or public health/regulatory medicine.

A senior Biotechnology and Microbiology major from Jordan, MN, Jacob Zahler has been working on an undergraduate research project titled, "Fungal single cell protein production on bioprocessed soybean meal supernatant," under the guidance of William Gibbons, professor in the Department of Biology and Microbiology.

"I screen a variety of different fungi on their growing abilities on the supernatant in order to reduce suspended solids and create an additional value added product," Zahler explains. "Soybeans are a major economic factor in South Dakota, so my research has the possibility of bringing an additional market opportunity to soybean farmers and an efficient way to bio-process a potential waste product."

Zahler is going to apply to graduate school at SDSU and hopes to continue with his project. His career plan is to obtain a master's degree in Microbiology and then work in the biotechnology industry.

By Sydney Sleep

Steven Kappes



"The need for leaders in agriculture will be even more important in the future than it is today."

Current Role: United States Department of Agriculture – Agricultural Research Service Deputy Administrator for Animal Production and Protection in the office of National Programs in Washington, DC. Kappes overseas five national program leaders in the areas of animal production, animal health, entomology and aquaculture research encompassing cattle, pigs, sheep, horses, trout, catfish and salmon. He is also responsible for the ARS Biosafety program.

Grew up near: Long Lake, SD, in the north central part of the state along the North Dakota border; Steven was the third child in a family of seven boys and two girls. The family farming operation included growing small grains and corn which was primarily used as feed for their cattle operation.

SDSU History: Attended SDSU from 1976-1980, earning a Bachelor of Science in Animal Science, then completed a Master's degree in Reproductive Physiology under the direction of Lowell Slyter in 1984.

Homage To His Dad: Kappes credits his innate interest in science to his father. Kappes tells, "In the 1960's, my dad was crossbreeding in our herd with Charolais and Brown Swiss bulls to get differences in milk and muscle. By the early 70's, he was implementing artificial insemination (AI) using semen from different sires and breeds and evaluating the effect on our cowherd. This was before I went to college, so when I took the Beef Production class at SDSU, I thought most of the information was common sense. However, as I talked to other students I came to realize my dad – even though he only had an 8th grade education – was doing some pretty cutting edge things on our farm."

Appreciation for SDSU: "I knew I was getting a good education. It prepared me well," says Kappes as he reflects on his time at SDSU. He adds, "There were a lot of good professors, and I really felt they cared about students." Kappes was particularly influenced by several interactions that occurred during his SDSU education – one of which was being on the Meat Judging Team coached by Bill Costello. Kappes explains, "Growing up in a small rural community, I wasn't as outgoing as most kids. The success I experienced through meat and livestock judging at SDSU gave me the confidence to keep taking risks and keep moving forward. Another influence came from taking a course taught by Lowell Slyter as a college senior. "That led me to pursue my Master's degree," Kappes says. He also credits Professor Bob Swanson for stimulating his interest in continuing his education and Professor Wendall Carlson for helping facilitate his enrollment in graduate school.

Prophetic Journey: Kappes tells of seeing a film in one of his freshman SDSU courses that highlighted the U.S. Meat Animal Research Center (MARC) in Clay Center, NE. "I told myself that would be a great place to work," he recalls. As he finished up his Master's degree, that dream became a reality. He spent seven years in research at MARC before pursuing his PhD at the University of Missouri in recombinant DNA technology – today known as the field of genomics.

Advice to students: "Take your education seriously, and seek opportunities to gain work experiences to find out your likes and dislikes," Kappes advises. As well, he says, "Don't narrow your area of expertise too quickly. The nice thing about a four-year degree is that it allows a broad base. You never know what opportunities may come your way down the road." He adds, "Don't be afraid to take risks for your career." Looking ahead, Kappes sees opportunity in agriculture both in the United States and internationally. He notes, "The need for leaders in agriculture will be even more important in the future than it is today."

Remembering his roots: In his role today, Kappes is involved in an array of agricultural research and policy issues – from antimicrobial resistance and animal disease management to biosafety and international activities. He notes that he relies on his core values and South Dakota experiences to guide him. "I strive to have a positive impact and make decisions that are based upon the effect on the family farm because those are my roots."



Scholarships Pay It Forward

My wife and I recall fondly the day we sat on our deck and clinked glasses in a celebratory “cheers” after mailing off our last student loan payment. Daycare, mortgage, car payments and other bills would continue. But we had one less expense each month moving forward.

During our discussion that day, we were moved to reflect on the fact that we reached this point earlier than some because of the generosity of people we didn't even know. We had the benefit of scholarships.

It was because of donors that we were having our celebration years earlier than we would have otherwise. We could now go out for a little nicer dinner every once in a while, start setting aside a little more for our childrens' educations, and begin to consider giving back at a higher level to charitable causes that were important to us.

There's no doubt about it; scholarship donors had made a difference in our lives.

I know from personal experience that “paying it forward” is a neat phrase that is fun to say, but sometimes difficult to do. Human nature is not to give away the things we have worked so hard to secure. Philanthropy is extremely personal, requires much reflection and is rarely arrived at easily.

When you provide a scholarship, you are having a profound impact on a specific student. It isn't always easy to write that check, but you will feel good about your decision when your head hits the pillow at night. I promise.

MIKE BARBER '97

THE PRESIDENTIAL PLEDGE

EXCELLENCE & ACCESS



The Jackrabbit Guarantee scholarship program was launched in 2001, leading to a growth in enrollment and higher ACT scores.

However, despite more than \$4.2 million in scholarship support from private sources every year, financial need is the most-common reason students cite for not completing their degree at SDSU.

The Presidential Pledge: Excellence and Access looks to lessen that barrier through a greater investment of

private resources and two new initiatives approved by the Board of Regents.

The comprehensive effort will help students at all levels -- from promising students faced with financial limitations, to high-achieving students coveted by institutions throughout the country.

Private investment is needed to provide scholarships for students that will compete for a Distinguished Scholar, Jackrabbit Guarantee or Jackrabbit Access award.

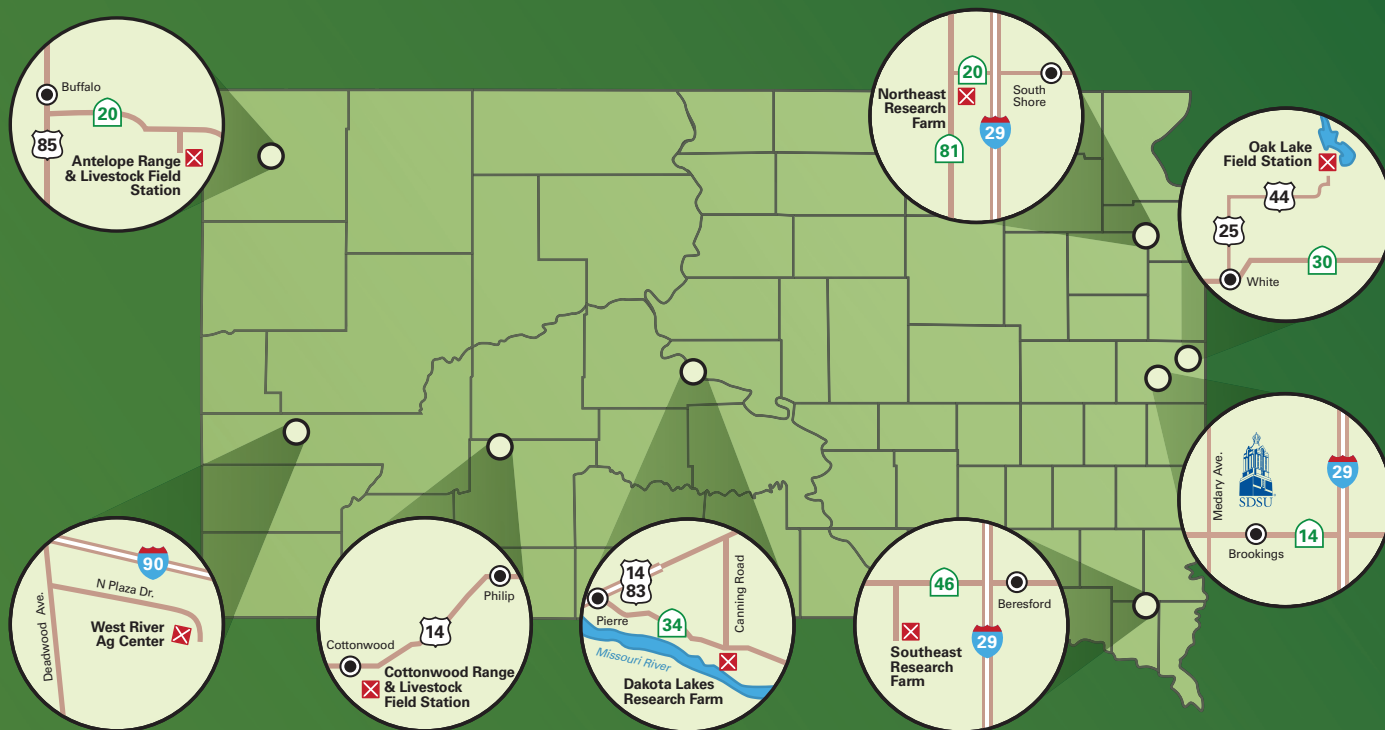
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For more information or to make a contribution, please contact the SDSU Foundation:

Mike Barber, Development Director
Marc Littlecott, Director of Gift Planning
Toll-Free: (888) 747-SDSU
www.SDStateFoundation.org

South Dakota Agricultural Experiment Station Locations



Research often begins on the SDSU campus in Brookings and the nearby livestock units and research plots. But for the science to be tried – and applied – in real-life settings, researchers also conduct ongoing studies at field stations operated by the South Dakota Agricultural Experiment Station across the state. The unique locations of each of these research facilities allow for diverse research responsive to the needs of the farms and ranches, businesses and lives of South Dakotans.

Plan to join SDSU faculty and staff for field days and events at these locations in 2016 as research updates and results are shared. Watch <http://www.iGrow.org/> for future event information.